Australian Entomologist, 2004, **31** (2): 69-74

SUSCEPTIBILITY OF CROP PLANTS TO *BEMISIA TABACI* (GENNADIUS) B-BIOTYPE (HEMIPTERA: ALEYRODIDAE) IN CENTRAL QUEENSLAND, AUSTRALIA

A.D. MOORE[1], R.V. SEQUEIRA[1] and T.A. WOODGER[2]

[1]*Agency for Food and Fibre Sciences, Queensland Department of Primary Industries, Locked Bag 6, Emerald, Qld 4720 (Email: Andrew.Moore@dpi.qld.gov.au)*

[2]*3 Harris St, Richmond, Qld 4822*

Abstract

An assessment of 10 crop plants for susceptibility to *Bemisia tabaci* (Gennadius) B-biotype (Silverleaf whitefly, SLW) was undertaken during the summer of 2001/2002 in central Queensland. Crops included in the assessment were chickpea, cowpea, lablab, mungbean, niger, peanut, sesame and soybean. Data on SLW abundance and preference ranking for each crop type are presented. Sesame was the most preferred for oviposition, mungbean was the least preferred while cowpea, peanut, niger, lablab and soybean were intermediate. Nymphs were more abundant on sesame, soybean and lablab than on mungbean, cowpea, niger and peanut. Chickpea was found to be unsuitable for SLW development. Crops such as sesame, soybean and lablab are likely to be high risk cropping options in parts of central Queensland where SLW is likely to become endemic.

Introduction

Bemisia tabaci (Gennadius) B-biotype, the Silverleaf whitefly (SLW), is an agricultural pest of global importance and a relatively recent introduction to Australia (De Barro 1995). The presence of SLW was first confirmed in 1994 from samples of whitefly collected on melons and nursery plants from Darwin, Northern Territory and Tamworth, New South Wales respectively (Gunning *et al.* 1995). Since its introduction, SLW has spread rapidly along coastal cropping regions of Queensland and New South Wales, where it is a major production constraint on a wide variety of horticultural, fibre, summer grain and oilseed crops (De Barro 1995, Gunning and Cottage 2000).

SLW was first detected in the Emerald irrigation area in 1998, mainly on ornamental plants in parks and gardens (Franzmann *et al.* 1998). However, the pest did not constitute a problem until the winter of 2001, when it reached outbreak proportions on a few cucurbit crops including pumpkin, melon and squash. In the following summer months (December 2001-March 2002), the pest spread rapidly and the central Queensland region experienced its first large-scale outbreak of SLW on summer grain, fibre and horticultural crops.

Here we report on the susceptibility to SLW of crop plants that are agronomically suited to central Queensland cropping systems. This study was part of a larger project to quantify the risk posed by this insect to cropping industries and enterprises across the region.

Materials and methods

The assessment was conducted at the Queensland Department of Primary Industries Research Station in Emerald (23°34'S, 148°10'E) on cracking black clay soil irrigated by overhead sprinklers. The field layout followed a randomised block design with 4 blocks (reps) and 10 plots within blocks. Each plot, measuring 4 m x 10 m (4 rows x 1 m spacing), was randomly assigned to one of 10 crop plants (treatments). The treatments were chickpea (*Cicer arietinum* (L.), cv 'Amethyst'), cowpea 1 (*Vigna unguiculata* (L.) Walp. cv 'Blackeye'), cowpea 2 (cv 'Red Caloona'), an annual lablab (*Lablab purpureus* (L.) Sweet cv 'Koala'), mungbean (*Vigna radiata* (L.) R. Wilczek cv 'Emerald'), niger (*Guizotia abyssinica* (L.f.) Cass. cv 'Courtice'), peanut (*Arachis hypogaea* L. cv 'Condor'), sesame (*Sesamum indicum* L. cv 'Edith'), soybean 1 (*Glycine max* (L.) Merrill cv 'Jabiru') and soybean 2 (cv 'Melrose'). Chickpea was the only winter crop and was included in this assessment solely to provide a benchmark for SLW development on a crop plant widely perceived to be an unsuitable host. The assessment was located adjacent to a mature cotton crop infested with SLW. Seed was planted on 23 January 2002.

Sampling commenced on 12 February 2002 after all seedlings had emerged and thereafter at weekly intervals for eight weeks. At each sampling time for all crop plants except chickpea, one leaf was randomly selected from the lower third of five plants in each plot and removed to the laboratory for assessment. Each leaf was notionally divided into quarters. One of the two quarters adjacent to the petiole was chosen at random and a cork borer was used to lightly impress a circular mark (diam. 11.25 mm; area 1 cm^2) onto the underside of each leaf. This sample area was then examined under a binocular microscope and the number of SLW eggs, small-medium nymphs (instars I-II) and large nymphs (instars III-IV including the 'red-eye' pupae) were recorded for each leaf.

A different sampling method was devised for chickpea because of its different morphology and small leaflet size. Several branchlets were collected and then sub-sampled so that approximately 30 leaflets (10 cm^2) became the sample unit.

The total numbers of eggs and nymphs per leaf on all crops except chickpea were analysed using a $\log_{10}(x+1)$ transformation and were subjected to ANOVA procedures with the host plant type as the grouping variable. The significance of differences between means was tested using the LSD test (Sokal and Rohlf 1995).

The Nymphal Transition Index (a measure of nymph survival on each host plant) that is defined as the ratio of large nymphs (instars III + IV) to small nymphs (instars I + II) was computed as a means of comparing host plant suitability for SLW development. The theoretical sampling distribution of the index was assumed to be normal. In view of this untested assumption, differences in estimated values of the index between treatments should be interpreted cautiously.

Results and discussion

SLW juvenile stages were recorded in all samples on every crop except chickpea. SLW had a patchy distribution with a trend towards high aggregations although some samples contained leaves with very few or no SLW. Field observations seemed to indicate that females oviposit more readily on leaves already infested. However, many of the eggs from these denser infestations appeared to be infertile.

Large numbers of dead SLW adults were observed on chickpea leaves. Quantification of adult SLW mortality on chickpea was beyond the scope of this study. Adult mortality appeared to have been caused by the acidic exudate of the chickpea foliage, but despite this, all juvenile stages of SLW were recorded on chickpea, albeit at very low frequencies (Fig. 1). Many newly-emerged adults appeared to have been killed after coming into contact with the foliar exudate even before they had successfully unfolded their wings. Subsequent chickpea samples contained noticeably fewer eggs and nymphs which supports the fact that chickpea foliage produces more acid with increasing maturity (Koundal and Sinha 1981), such that older plants become increasingly hostile hosts (Romeis *et al.* 1999). These observations support the widespread belief that chickpea is generally not a suitable host for whitefly development. For these reasons, chickpea was excluded from subsequent analyses of SLW abundance.

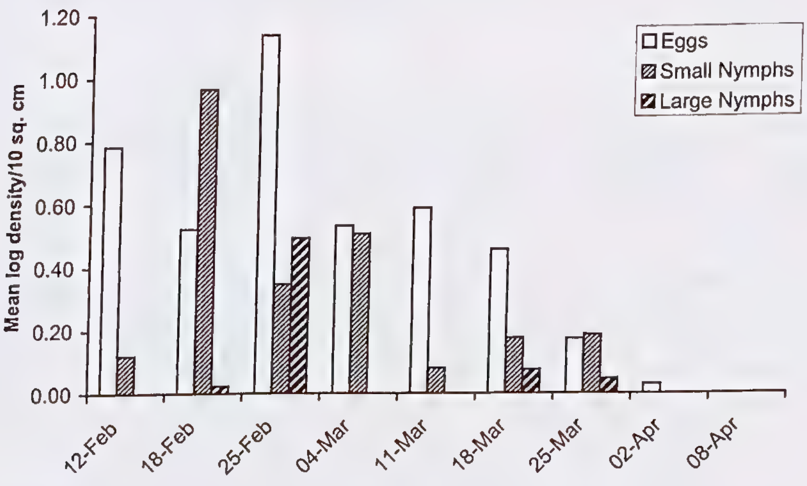

Fig. 1. Temporal abundance of SLW eggs, small (instars I and II) and large (instars III and IV) nymphs on Chickpea.

Oviposition preference

The host plants could be classified into three groups (Fig. 2). Sesame was a preferred host attracting a significantly greater number of eggs than any other crop whereas mungbean was least preferred (Fig. 2). Cowpea, niger, lablab, peanut and soybean were intermediate for oviposition. There was sustained oviposition pressure on sesame, soybean and lablab throughout the assessment with egg densities often as high as 1000 cm^{-2}.

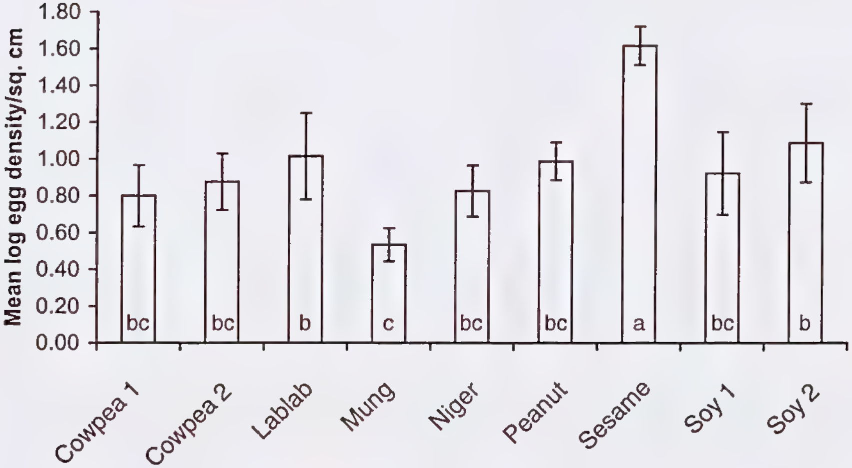

Fig. 2. Mean abundance of SLW eggs on nine crop plants. Letters indicate statistical significance of differences between means (LSD Test, $\alpha = 0.05$). Means sharing the same letters are not significantly different.

Nymphal density

The host plants could also be classified into three groups with respect to nymphal SLW abundance, although the overlap among groups was greater (Fig. 3). Mungbean, cowpea, niger and peanut had comparatively few nymphs whereas sesame, soybean and lablab had the highest numbers of nymphs throughout the assessment. As first instars do not move very far after hatching, these large egg densities resulted in nymphal densities greater than 500 nymphs cm^{-2}. Physical space becomes a scarce resource as these nymphs grow and mature. The mature nymphs and pupae are many times larger than the first instars and in some extreme cases crowding meant that pupae were scarcely in contact with the leaf surface. Plants appeared to sustain quite high levels of insect attack before leaves showed signs of senescence.

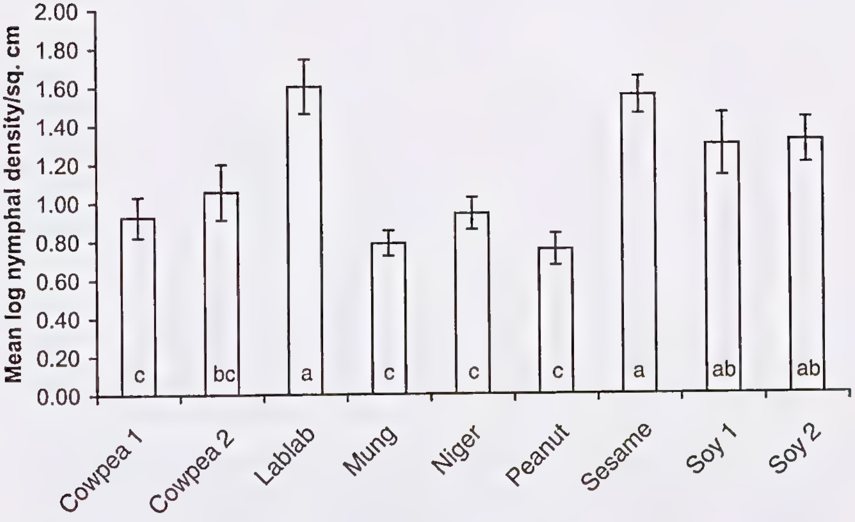

Fig. 3. Mean abundance of SLW nymphs on nine crop plants. Letters indicate statistical significance of differences between means (LSD Test, $\alpha = 0.05$). Means sharing the same letters are not significantly different.

Nymphal Transition Index

There was considerable variation in the nymphal transition index among host plant species (Fig. 4). Few SLW individuals developed to the late nymphal stages on mungbean, sesame and peanut. By comparison, a greater proportion of eggs laid on lablab, cowpea and soybean developed through to large nymphs and adults. Low egg and nymphal abundance combined with a low transition index value on mungbean strongly indicated that this host is not preferred by adults and is less suitable for nymphal development than the other hosts evaluated. In contrast, sesame was highly preferred for oviposition and harboured large numbers of small nymphs. However, competition for plant resources experienced by the small nymphs is a likely cause for relatively fewer individuals developing into large nymphs on sesame. Thus, SLW survival to the adult stage on sesame may be a function of density-dependent mortality of small nymphs.

By virtue of their susceptibility to SLW infestation, sesame, soybean and lablab must be considered high risk cropping options in parts of central Queensland where SLW is likely to become an endemic pest. In such areas, mungbean is likely to be a safer cropping alternative.

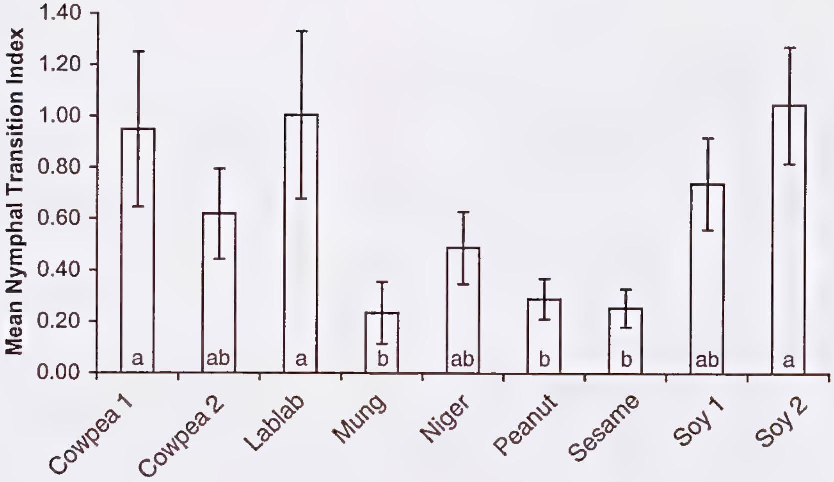

Fig. 4. Mean SLW Nymphal Transition Index on nine crop plants. Letters indicate statistical significance of differences between means (LSD Test, $\alpha = 0.05$). Means sharing the same letters are not significantly different.

Acknowledgements

This work was jointly funded by the Cotton and Grains R&D Corporations.

References

DE BARRO, P.J. 1995. Bemisia tabaci *biotype B: a review of its biology, distribution and control.* CSIRO Division of Entomology Technical Paper No 36; 2nd Edition; 58 pp.

FRANZMANN, B.A., LEA, D.R. and DE BARRO, P.J. 1998. The distribution and parasitism of biotypes of the whitefly *Bemisia tabaci* in cotton areas of Queensland. Pp 461-463, in: *Proceedings of the Ninth Australian Cotton Conference, Broadbeach, Gold Coast, Queensland.* Australian Cotton Growers Research Association, Brisbane.

GUNNING, R.V. and COTTAGE, E. 2000. The spread of B-Biotype *Bemisia tabaci* into Australian cotton. Pp 161-164, in: *Proceedings of the Tenth Australian Cotton Conference, Brisbane, Queensland.* Australian Cotton Growers Research Association, Brisbane.

GUNNING, R.V., BYRNE, F.J., CONDÉ, B.D., CONNELLY, M.I., HERGSTROM, K. and DEVONSHIRE, A.L. 1995. First report of B-biotype *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in Australia. *Journal of the Australian Entomological Society* **34**(2): 116.

KOUNDAL, K.K. and SINHA, S.K. 1981. Malic acid exudation and photosynthetic characteristics in *Cicer arietinum. Phytochemistry* **20**: 1251-1252.

ROMEIS, J., SHANOWER, T.G. and ZEBITZ, C.P.W. 1999. Why *Trichogramma* (Hymenoptera: Trichogrammatidae) egg parasitoids of *Helicoverpa armigera* (Lepidoptera: Noctuidae) fail on chickpea. *Bulletin of Entomological Research* **89**: 89-95.

SOKAL, R.R. and ROHLF, F.J. 1995. *Biometry.* Third Edition. W.H. Freeman & Co., New York; xix + 887 pp.